Editorial

Optimism by the Hat-full

WE ARE TOLD on good authority that a lady with a new hat is bound to be optimistic in her outlook on life. However that may be, we feel decidedly optimistic looking at our new cover and format this month. The attempt has been made to retain the best of tradition in the Society without enslavement to mere repetition of what has long since lost purpose. The cover has not been abandoned to the camp of the modernists, yet is compatible with the times. In other words, we entertain the hope that you will share our optimism.

A word about editorial policy as it affects this new undertaking. The Technical Section made up of submitted papers will retain its scientific integrity on a high professional level, and will continue to dominate the contents. Technical reviews, discussion, and news beyond that provided by technical papers, recognized as an additional need when the *Journal* began in 1948, continues in this issue as the "Current Affairs" Section. But even this falls short of supplying an adequate digest of all available information valuable to electrochemists. Our friends in industry, for example, have no opportunity in technical papers or reviews to present their specialized announcements and information of commercial makeup. Nevertheless, knowledge of currently available services, products, books, and equipment pertinent to the field of electrochemistry is useful to each of our readers whether in industry or the universities. To provide this information, therefore, we plan to set aside a certain amount of space for advertisements. The return from this space will eventually aid, we hope, in supporting a streamlined publication able to accommodate a larger number of high quality technical and scientific papers from this country and abroad. Increased financial support will also make possible increased space devoted to feature articles and current affairs.

The Editorial Staff is pleased to present the Society's "New Hat," and hold it as a forerunner of better things to come.

THE ELECTROCHEMICAL SOCIETY, INC.

The Electrochemical Society is an international organization of individuals and companies concerned with or interested in Electrochemistry and allied subjects.

The Society is dedicated to the advancement of the theory and practice of Electrochemistry and related subjects, as shown in the following divisions:

Battery	Electro-Organic
Corrosion	Electrothermic
Electric Insulation	Industrial Electrolytic
Electrodeposition	Theoretical Electrochemistry
Electronics	

Among the means to this end are the holding of meetings for the reading and discussion of professional and scientific papers on these subjects, the publication of such papers, discussions, and communications as may seem appropriate, and cooperation with chemical, electrical, and other scientific and technical societies.

It is an incorporated society without capital stock. The affairs of the Society are managed by a Board of Directors under a Constitution and By-Laws. Officers are nominated by a nominating committee appointed by the Board of Directors and elected by the members.

Direct all general correspondence and inquiries regarding membership to Society headquarters at 235 West 102nd Street, New York 25, N. Y., c/o Mr. W. J. Holian, Assistant Secretary.

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Technical Reviews

Review of Articles on Luminescence for 1949

*Gorton R. Fonda**

The past year has brought out evidence of an increasingly active interest in the study of luminescence. There have been two symposia on the subject, one in March under the auspices of the Optical Society of America and a second one in May at a meeting of The Electrochemical Society. The former produced a monograph on luminescence by devoting the August issue of its *Journal* to the publication of eighteen articles on luminescence. Pringsheim's long awaited book has appeared and will undoubtedly become a classic (1). Leverenz has published in *Science* a notable preview of his forthcoming book, an article which summarizes the author's experience and opinions on the preparation, properties, and constitution of phosphors and his interpretations of them, all in highly readable form, understandable by the novice and suggestive to the expert (2).

Two important reviews have been published. Nottingham has given a survey of present methods used to determine the optical properties of phosphors (3). After presenting the theory of phosphors in terms of the electron band picture, he describes the automatic spectroradiometer, the importance of standards, and the application of the I.C.I. system to the design of television screens. There is also a discussion of phosphorescence and of spectral excitation as correlated with absorption data. The second review is by Williams on the interpretation of luminescence phenomena (4). After discussing the band theory model and the configurational coordinate model, he describes experiments on the temperature quenching of luminescence, two-stage afterglow, thermoluminescence, electron retrapping, and positive hole migration and accompanies each with a theoretical treatment.

Articles on individual aspects of luminescence are reviewed below under appropriate headings. The reviews are necessarily scanty. Their aim is to give a bird's eye view of the year's accomplishments and to guide the reader to those articles of interest to him. Where nothing is said or implied about the source of ultraviolet excitation employed, it is to be understood as 2537 Å.

This review does not cover articles written in Russian. The Russians, however, have been very active. Out of forty articles summarized in "Chemical Abstracts," ten deal with phosphorescence, seven with infrared sensitive phosphors, seven with temperature dependence of luminescence, five with thermoluminescence, and eleven with general problems of emission. The sulfides and halides are the phosphors most actively studied.

New Phosphors

The word "phosphor" was originally coined to designate a solid which emits luminescence when excited by light of shorter wavelength. When an element was discovered which became luminous under oxidation at room temperature, the cause of its luminescence was not recognized and it likewise was mistakenly called a phosphor. Hence the name of our element, phosphorus. It is appropriate that this early error should now be rectified to a degree, by the discovery that phosphates may in fact be phosphors, for the most notable of the new phosphors are compounds of the phosphates, the alkaline earth halophosphates discovered

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by McKeag and Ranby (5) and the magnesium pyrophosphates discovered by Froelich (6). They are noteworthy because of the importance of their technical application in fluorescent lamps and also because they emphasize the importance of sensitized luminescence, the effect of a secondary activator in making possible the excitation of emission from the primary activator.

The halophosphates have apatite structure. Their fluorescence may be rendered white by using appropriate concentrations of the secondary activator, antimony, emitting a blue band, and of the primary activator, manganese, emitting in the red. The best known are the calcium halo compounds, but several substitutions may be made for constituent elements. Their characteristics have also been described by Nagy, Wollentin, and Lui (7).

In the magnesium pyrophosphates, cerium is the primary sensitizing activator. With thorium as well, an ultraviolet band is emitted whose peak lies in the range 3440-3560 Å, depending upon thorium content. When manganese also is added, a relatively bright yellow-orange emission appears in addition to the ultraviolet.

Another phosphate is that of aluminum, activated by tin and manganese and emitting in the blue and red. The discovery of this was announced by Anderson and Wells, who describe also a barium zinc silicate with manganese, emitting a deep red (8).

One of the most interesting of the new phosphors from the standpoint of interpretation is the zinc beryllium germanate with manganese of Schulman, Ginther, and Claffy (9). It is similar to the corresponding silicate in that increase in either manganese or beryllium causes a new band to appear in the red, in addition to a green band. It is different, however, in that this effect extends beyond the solubility limit of beryllium as substituted for zinc. The additional beryllium may be incorporated in the lattice by substitution for germanium.

Some novel developments have also been made in the sulfide class of phosphors. McKeag and Ranby describe a new zinc sulfide, activated with phosphorus to emit a band at 5600 Å (10). In conjunction with the blue band of the unactivated sulfide, the intensity of the phosphorus band may be so regulated that the overall emission is white.

Kroeger has extended his conception of the role of halide fluxes in zinc sulfide to demonstrate that, at liquid air temperature, the presence of lithium chloride gives a band at 4380 Å and that of sodium chloride two bands in the near ultraviolet (11). In the absence of chlorine, these elements act as quenchers.

In a study of the strontium sulfide phosphors, Pearlman, Goddard, and Urbach discovered that strontium oxide is also the base for phosphors of the Lenard type (12).

Jones announces an aluminum oxide activated with iron to emit in the deep red (13). Weyl, cooperating with other investigators, has extended his earlier work on activation by atomic silver to silicate and phosphate glasses in addition to sodium chloride crystals (14).

In investigating bismuth as an activator, Kroeger finds that it forms fluorescence centers in its own compounds as well as in other systems, such as the sulfates and phosphates (51). Its emission in the latter is red.

Preparation of Phosphors

A unique method of differential thermal analysis has been used by Rice to record the temperature at which reaction occurs in the formation of zinc silicate types of phosphors (15). Mixtures are heated at a uniform rate of increase. The exothermic effect produced by the beginning of a reaction is recorded as a temperature differential between the reacting mixture and an aluminum oxide blank. Inasmuch as the temperatures reported are considerably lower than those found necessary in phosphor preparation, the reader has a suspicion that they record the formation of a film of phosphor only and that a second differential would occur at a higher temperature where diffusion becomes appreciable.

Smith has studied the influence of various fluxes on the formation of zinc sulfide phosphors (16). He is in agreement with Kroeger that part of a flux may become an essential ingredient of the phosphor. In an attempt to confirm an earlier conclusion that chloride is an essential ingredient for the blue fluorescence of unactivated zinc sulfide, Kroeger has subjected samples of the phosphor to intensive washing and then analysed them for residual chlorine (17). The amounts found are roughly proportional to the brightness of fluorescence.

Phosphor Characteristics

Considerable attention has been given to the recording of multiple emission bands whose occurrence is associated with the presence of a single activator. In some of these cases, serious attempts have been made at their interpretation. The most complex emission is that of the manganese activated magnesium germanate, disclosed by the investigation of Patten and Williams (18). There are five distinct bands between 6200 and 6800 Å. The intensity of each increases to a critical temperature above which it decreases. Free divalent manganese has several excited states, each with five or six multiplet sub-levels separated by energies which are approximately the same as the differences in peak energies of the emission bands.

Several investigators have attempted to analyze the structure of the emission from zinc silicate phosphors. They agree rather closely on the number and location of constituent bands having Gaussian distribution, even though these bands are not as nicely and sharply defined as in the case of magnesium germanate. According to Nagy's measurements, they lie at 4980, 5250, 5470, 5690 and 6030 Å and their positions are almost independent of temperature (19). He suggests an analogy between their positions and the absorption spectra of permanganate and manganate compounds. Further evidence for this is given by Makai (20). A further analysis of the situation is given by Brinkham and Vlam, who present evidence for fine structure in other phosphors as well, calcium tungstate, magnesium tungstate and the zinc sulfides (21). Shrader contributes some unexpected experimental results for the emission of the zinc silicates (22). In addition to bands at 5275 Å and 5665 Å for the crystallized orthosilicate, he finds at −196°C a line at 5175 Å. The high temperature-

quenched form, emitting normally a band at 5665 Å, develops at −196°C two additional strong bands at 5176 Å and 5420 Å and two very faint lines at 5350 Å and 5380 Å. Butler has studied the emission from manganese activated zinc silicate and from lead activated calcium and barium silicates (23). He offers an explanation for emission bands having Gaussian distribution on the basis of a potential energy curve model.

The dependence of fluorescence efficiency and quenching upon intensity of excitation and temperature have been studied by Kroeger and Hoogenstraaten for the zinc silicates and the results related to differences in the character of the fluorescence centers corresponding to the constituent emission bands cited above (24). They ascribe the centers to differences in clustering of manganese ions. Their experimental results and interpretive treatment are to be compared with studies of Urbach on sulfide phosphors, mentioned below (27).

The three bands, 3000, 3340 and 3500 Å, occurring in the emission of calcium silicate activated with lead, are ascribed by Studer and Fonda to three silicates of different constitution (25). They show also that, when both manganese and lead are present, the manganese emission comprises two bands and that the band of shorter wavelength is favored by reduction in manganese concentration and by increase in temperature.

As still another instance of the occurrence of multiple bands, Smit and Kroeger have contributed to an understanding of the emission from lead activated zinc sulfide (26). The orange band at 6100 Å is favored by sulfurizing conditions and appears whether halide ions are present or not. The green band at 4850 Å is favored by reducing conditions and appears only when chlorine ions are present.

Nail, Urbach, and Pearlman have extended their studies on the relation between luminescence efficiency and intensity of excitation (27). Whereas they had found previously that this relation was linear, they now find for a series of poisoned zinc cadmium sulfides that it may be very much higher than linear. A discussion is given of the modifications to the theory that this necessitates. They have applied these characteristics to the development of phosphors whose luminescence serves as a temperature indicator (28). The method is suitable for observing and recording temperature distribution. Related experiments have been made by Becker (53).

The saturation current for the light output under stationary cathode ray excitation has been measured by Bril for zinc silicates with manganese or titanium and for zinc sulfide with silver (29). He finds it to depend on the activator content, the presence of quenchers and the decay time.

The intensity of emission under radiation from 170 Å was measured photographically by Tomboulian and Pell (30). A preliminary trial with a photomultiplier tube equipped with calcium tungstate, the most responsive phosphor, showed that 1000 Å radiation was detected. With improved equipment it was estimated that weak soft x-rays in the far ultraviolet could be similarly detected.

The photoconductivity reported by Randall and Wilkins for single crystals of calcium and cadmium tungstate could not be found by Klick and Schulman under radiation within the range 2200–4000 Å (31). They were unable also to detect any luminescence under 3650 Å.

Some further experiments have been made with zinc beryllium silicate. Lowry presents further information on the deterioration of fluorescent lamps containing it and magnesium tungstate (32). According to his analysis, the deterioration involves three different processes occurring at three different rates of speed, (*a*) a gas phase reaction between the phosphor and mercury vapor, limited to 100 hours; (*b*) a solid phase reaction with some constituent of the glass, such as sodium, which is reduced by addition of antimony oxide; and (*c*) a photochemical reaction. Fonda has determined the deterioration of zinc beryllium silicate in lamps under different conditions of preparation (33). He has also measured the relation between phosphorescence decay and composition and has redetermined the solubility limit of beryllia to be 25 molar per cent at 1260°C in contrast to 30 molar per cent found previously at fusion.

A broad review is given by Barnett and Grady of the properties and performance of fluorescent materials when incorporated into a medium such as paint, plastic, or textile (34). It includes data on the relation between ultraviolet intensity and fluorescent brightness and on the masking effect of ambient illumination. Related to this is the work by Plymale and Dawson on the photometric evaluation of luminous materials at low brightness (35), and the studies by Peckham on measuring the luminescence of fluoroscopic x-ray screens (36).

A vacuum ultraviolet monochromator has been developed by Parkinson and Williams for measuring absorption and photoconductivity in the region of 1000 Å to 2000 Å (37). They have used it to measure the spectrum of a hydrogen discharge and the absorption of zinc fluoride.

Thermoluminescence and Phosphorescence

The subject of thermoluminescence as displayed in the flow curve technique continues to be of increasing experimental value and theoretical significance. Garlick emphasizes the need for extensive and precise experiments and the difficulty of fitting the stimulation characteristics of phosphors into existing theoretical models (38).

As an example of the preciseness desired by Garlick, the work of Johnson and Williams on zinc fluoride is notable (39). Their measurements show at least six individual glow peaks between 100° and 700°K, with relative intensities depending upon crystallization temperature and annealing. The data are accompanied by short but detailed theoretical analyses.

Two characteristic pieces of work of the same nature come from the Garlick school. Garlick, Wells, and Wilkins have examined the effects of constitution and activator upon the trap depths of the zinc sulfide phosphors (40). Their results support the contention of deep traps as explanation for the very strong phosphorescence associated with copper. Garlick and Mason have studied the relation between electron trap distribution, deduced from thermoluminescence experiments, and the infrared stim-

ulation characteristics of the zinc sulfide and alkaline earth sulfides (38). In conventional phosphors, the light sum on stimulation is much less than under thermoluminescence, whereas the reverse is true for infrared sensitive phosphors. The decay of stimulated luminescence is different for each stimulation band. In certain zinc sulfide phosphors with copper and lead and for stimulation by certain wavelengths, the decay is exponential, but in general it is hyperbolic. In some cases, the thermal glow curve and light sum are greater after stimulation than before, denoting that electrons released from deep traps are retrapped in shallow ones.

New experiments by the Urbach school on the forced decay of infrared sensitive strontium sulfide phosphors show that states of different stability toward infrared co-exist in them (41). The kinetics of the results are discussed.

Scott, Thompson, and Ellickson present results of experiments on the variable inertia effects that occur during the induction period of stimulation of infrared sensitive phosphors (42). The behavior of Standard VI, whose brightness rose first abruptly and then gradually, led them to conclude the presence of two separate processes of light emission. This question has been studied theoretically by Herman and Meyer (43).

The Roland Ward school has continued its activity in studying the properties of strontium sulfide and selenide infrared sensitive phosphors as dependent upon composition and preparation. The selenide shows a similar effect of activator concentration as found previously for the sulfide (54). The most unique contribution of these investigators has been to determine the distribution of the activators europium, cerium, and samarium between the base sulfide or selenide and the flux (55). This was done by adding an adequate amount of a radio isotope to each of the activators in turn, heating till equilibrium was attained and then filtering through a platinum or nickel porous mat at 1000°C. The results furnished the explanation for the decrease in brightness caused by the presence of strontium oxide.

The complex decay of doubly activated phosphors has been measured by Studer and Rosenbaum for the halophosphates, calcium silicate, and zinc fluoride phosphors (44). In all cases there is initially a very rapid and abrupt decay, characteristic of the emission band due to the sensitizing activator. This is followed by a second stage of decay having a slow rate, characteristic of the manganese emission. Both stages are of the exponential type.

Byler and Kirkpatrick have formulated results of their measurements on the decay of various phosphors of the zinc sulfide type and have presented an explanation for them (45).

The variation of cathodoluminescence efficiency with increase in temperature has been studied by Bube for several phosphors (46). After the initial decrease in efficiency, a pronounced increase was found for zinc fluoride above 210°C. Similar but much more limited effects were found for phosphors of the zinc sulfide type.

Wilber has given an interesting mathematical study of the variation in brightness of a phosphor having exponential decay when excited by a cathode ray beam of constant voltage, at a beam current which varies sinusoidally about a constant d-c value (47).

Characteristics of Luminescent Screens

In an important article, Sadowsky has described fourteen methods for obtaining luminescent screens and has given a detailed description of liquid settling as applied to television tubes from a phosphor suspension in potassium silicate containing sodium sulfate (48). The role of the latter in promoting adhesion of phosphor to the glass is demonstrated by Edelberg and Hazel to consist in a lowering of the surface potential (49).

The visibility of cathode ray screens in radar tubes has been the subject of careful measurements. The effects have been studied of the size of pip, the exposure time, and the viewing angle (50).

A novel method consists in forming a sulfurous deposit which is capable of picking up phosphor powders. The sulfurous material is then driven off by heating (52).

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MANUSCRIPTS FOR SPRING MEETING

Manuscripts are now being received for the Ninety-Seventh Meeting of the Society, to be held at the Statler Hotel in Cleveland, Ohio, April 19, 20, 21, and 22, 1950. To be considered for this meeting, *triplicate copies* of manuscripts or abstracts must be received by the Editor of the JOURNAL, 235 West 102nd Street, New York 25, N. Y., *not later than* February 15, 1949.

Scheduled symposia for the Spring meeting are: Electric Insulation, Electrothermics, Industrial Electrolytics, Instrumentation, Luminescence, Rare Metals, and Theoretical Electrochemistry.

Developments of Germanium and Gallium During 1949

John R. Musgrave

Germanium

The major use of this metal has been in electronic applications due to the properties of germanium, when suitably alloyed, as a semiconductor.

High back-voltage rectifiers based on germanium have been in commercial production for several years and have decided advantages over other types of rectifiers. Earlier publicity on germanium rectifiers claimed that they would render obsolete other types of rectifiers; it is becoming increasingly evident that, like many other new discoveries, the germanium rectifier will occupy an important place in the field, but will not displace entirely vacuum tubes or selenium rectifiers.

Bell Telephone Laboratories, during 1948, announced their transistor which was described as a semiconductor triode. It can be used as an amplifier, oscillator, or to replace the vacuum triode. This unit is not as yet in commercial production, but it appears to have great possibilities.

Recently Sylvania Electric Products has announced a germanium tetrode. While few details have been released on this new application, it is probable that it will have a definite impact on the electronic field.

Further fundamental work on germanium is being conducted at a number of research laboratories, notably Purdue, General Electric, Bell Telephone, and Sylvania Electric Products. It is to be expected that the unique properties of this rare metal will be found useful in other fields as more basic fundamental information is developed.

Gallium

Gallium, because of its low melting point (20°C), its high boiling point (over 2000°C), and its low vapor pressure over a wide range, has evoked considerable interest; however, its tendency to alloy with most metals has been somewhat of a disadvantage in many proposed applications.

It has been reported that gallium was considered as a heat transfer agent in the atomic pile. Difficulties were encountered in this application and the present price (approximately $3 (per gram) also militated against its use.

Considerable research work has been done on gallium and its compounds, but very little has been published.

The rumors of the possibilities of gallium in the atomic program, published in many of the mining journals with erroneous figures on the value, has aroused wide-spread interest and much confusion; many of these articles listed gallium as commanding prices up to $100 per gram. It is only natural that prospectors consider it a bonanza metal. Actually, very little gallium is being used except for experimental purposes at the present time.

It is not at all unlikely that the wide-spread interest in this rare metal and research work being done on it may develop new and unexpected uses. It is interesting to know that one of the isotopes of gallium is being used in the study of bone cancer.

J. R. Musgrave graduated from Lafayette College in 1927 with a degree in Chemical Engineering. Following a period of industrial research, he entered the Graduate School at the University of Toronto. He received his Ph.D. degree, majoring in Physical Chemistry, in 1933. Shortly after the completion of his graduate work, he became affiliated with the Eagle-Picher Research Laboratories at Joplin, Missouri. His present position is Chief Physicist in charge of the Physical-Chemical Section of the Eagle-Picher Research Laboratories.

His research activities cover work on thermal insulation, paint, storage batteries, corrosion, and instrumentation and rare metals. He is the author of several papers on particle size determination as applied to very fine materials. He is perhaps best known in The Electrochemical Society for his interest in rare metals.

He has been a member of The Electrochemical Society since 1941, having participated in the activities of several of the divisions. He assisted in the 1949 symposium on Rare Metals and is at present Secretary-Treasurer of the Electronics Division of the Society, as well as a member of several committees of the Society.

J. R. Musgrave

97th Meeting of The Electrochemical Society

Statler Hotel, Cleveland, Ohio **April 19, 20, 21, and 22, 1950**

Feature Section

Research in Industry—Is Government Antagonistic to It?*

Oliver W. Storey

The many spectacular developments of the past decade, highlighted by the atomic bomb development, have convinced the public that science has become a most important factor in their lives. They have learned further that research is responsible for these spectacular scientific developments. As soon as the politicians sensed this reaction of their constituents, science, and particularly research in the natural sciences involving physics, chemistry and electricity, was kicked into the political arena. Research suddenly has found itself in unfamiliar surroundings and it is struggling to acclimate itself to this new atmosphere. There are many scientists who decry this new association but I cannot share that feeling. I believe that through it scientists eventually will assume their proper place in government and thereby be in a better position to improve the present attitude of government toward research. Science thereby will profit much more than by staying aloof as it has in the past.

Now that research is in politics I believe that we who are interested in research should be apprised fully about the government's attitude toward it. The government, and I am referring particularly to the Federal government, through the functioning of its executive, legislative, and judicial branches, has established a record over a period of time which fully discloses its attitude. It is my purpose in this paper to lay before you the more important part of that record. In doing so I shall, for illustrative purposes, refer occasionally to the experiences of the several companies founded by the late Dr. C. F. Burgess which were based on the research work both done and directed by him. Their experiences, particularly in tax and patent matters, reveal much about the attitude of government toward research. I can speak with real feeling about those experiences because my long association with the Burgess companies includes a financial interest.

The attitude of government toward patents is of importance in the consideration of this subject. For the patent phase I have not only drawn upon my experiences in directing the patent activities of the Burgess companies but also upon those gained over the past twenty years as a member of the Committee on Patent and Related Legislation of the American Chemical Society.

The public has heard much about government's support of research during the past decade. A considerable number of governmental bureaus carry on research as a part of their normal activities. Another large amount of research work is farmed out to various institutions, both public and private, including manufacturing concerns. The total of these research expenditures runs into an impressive hundreds of millions of dollars. Furthermore, Congress has been considering the establishment of a National Science Foundation ever since Dr. Vannevar Bush (1) made his famous "Science, the Endless Frontier" report to President Truman in 1945. These governmental activities make a *prima facie* case for those who maintain that government favors research. However, let us examine that which is hidden by this glittering facade.

The research discussed in this paper refers more specifically to original research, as exemplified by the papers published in the Technical Section of our Society's JOURNAL, and not the routine research of an industrial plant that is usually termed "engineering." There is, however, no clear line of demarcation between the two. Successful research results usually are patentable inventions. Because this paper deals with research in industry it will be concerned largely with applied as distinguished from basic research.

In industry the profit motive is the compelling factor in conducting research, or, as Dr. Robert E. Wilson, Chairman of the Board of Standard Oil Company of Indiana, recently put it, "Industrial research is simply the teaming up of the hope of profit with the spirit of research." To avoid a possible incorrect inference from that statement it may be said that the profit motive usually is in the background even though the research work is done by government or in a nonprofit institution. The government hopes that profit will accrue to some citizen or taxpayer—farmer, miner, manufacturer, etc. The profit motive is emphasized because it is the basis of this paper. Without profits, private industry cannot exist. Industrial research, therefore, must justify itself by producing

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results which will yield a profit on the investment made in it.

Government and Patents

Patents generally are considered necessary by industry to implement fully the other means used to secure the profits that must be derived from applied research. Furthermore, many consider patents an important factor in the outstanding industrial progress made in the United States. The attitude of government toward patents and the patent system is, therefore, of importance in ascertaining its attitude toward industrial research. During the past decade a voluminous record has been created by all three branches of government in all their ramifications. That record is so clear and so much of it has appeared in print, that it will not be necessary to do more than generally review the subject.

Section 8 of the Constitution of the United States lists the specific powers that the Congress shall have. Among them is the power "To promote the progress of science and arts, by securing for limited times to authors and inventors, the exclusive right to their respective writings and discoveries." I wish to emphasize that the right the inventor receives is an exclusive one, that is, it is a monopoly. The monopoly, however, is of limited duration.

Those who would destroy free enterprise and saddle statism on us are waging a constant war on the patent system to render it impotent. One of their favorite tricks in the misleading propaganda that they disseminate is to quote the above clause of the Constitution incorrectly by omitting the all-important "exclusive" from it. Leave that out and the patent system falls apart. And some of our government officials and representatives have omitted this word in their publicized discussions of the patent system.

In attacking the patent system its opponents usually lay much emphasis on the monopoly created by the patent grant and attempt to confuse the public into believing that the patent monopoly is not unlike the trust and cartel monoplies which are prohibited by law. In these attacks there is overlooked, ignored, or misrepresented, the fundamental fact that when a patent is granted it covers nothing which existed previously in the public domain. On the contrary, it adds value to that domain because the inventor, upon receiving the patent grant, discloses the invention to the public and automatically assigns it to the public 17 years later. During this 17-year period he has only the right to exclude others from making, using, or vending it without his permission or license.

The government itself, and particularly the executive branch as represented by the Antitrust Division of the Department of Justice, has been the leader in attacking the patent system and particularly patents growing out of industrial research. Thurman Arnold, the spectacular head of that Antitrust Division a decade ago, led the government's assaulting brigade in its attack on patents. There has been a continuous barrage of statements from the Antitrust Division since then. Arnold is probably well remembered for his testimony on March 11, 1941, before the House Committee on Patents at which time he accused industrialists of hampering the Army and Navy by means of patents. He failed to produce any evidence to support that charge (2). When the ethyl gasoline patents were under discussion at the time, Arnold (3) testified: "Now whether these (ethyl) patents were good, I do not know. It struck me at the time, what else could you do with tetraethyl lead but put it in gasoline? You can't put it in coffee!" Research is just as easy as that!

Arnold, as a member of the executive branch of the government, advocated making a number of changes in the patent system, all of which would have weakened it and would have greatly increased the hazards of doing industrial research, especially by small business. He laid particular emphasis on his proposal for the compulsory licensing of patents, a proposal that was discussed and debated at length in the newspapers, the scientific press, before the scientific societies, and in Congress. This proposal is a logical one if the inventor is not given an exclusive right to his invention. He also proposed the elimination of all restrictions in licenses, such as, for example, territory and use restrictions. He also proposed other limitations on the licensor, but it is not necessary to catalog them here. Arnold, after becoming a Federal judge, had further opportunities for showing his antagonism toward industrial research and later I shall refer to one of his opinions.

The alleged basis for Arnold's antagonism to the patent system was the testimony given before the now largely discredited TNEC (Temporary National Economic Committee). A product of that highly-prejudiced investigation as it related to patents is TNEC Monograph No. 31, entitled "Patents and Free Enterprise," published in 1941 and prepared by Walton Hamilton, Professor of Law at Yale University (4). For those interested, a scathing reply to his vicious attack on the patent system, which had little foundation in fact, was made by Anthony W. Deller (5), patent attorney, in the *Harvard Law Review* for November, 1942.

The TNEC report was followed by the introduction in Congress of numerous bills for hobbling the patent system in accordance with the ideas expressed by Arnold and seconded by certain Senators, including particularly Kilgore, Pepper, and Bone. A closely related bill was the Kilgore so-called Science Mobilization Bill, introduced in 1943. All of these bills were defeated in congressional committees following extended hearings in which their proponents established a new political low in their failure to tell the whole truth, and in the use of innuendos, false conclusions, and misleading impressions. At this time I wish to pay tribute to one of our long-time members, Walter A. Schmidt of the Western Precipitation Company of Los Angeles, who, as chairman of the Committee on Patent and Related Legislation of the American Chemical Society during the World War II period, fought these bills, often before a hostile committee, with skill and determination, probably at the cost of a considerable sacrifice of time, energy, and money. All scientific men owe him a debt of gratitude for the service he rendered to them by his courageous fight which helped defeat the antipatent bills.

Though these early proposals were defeated at that time, the executive branch has never dropped its advocacy of these radical measures. As late as February 17 of this year,

the Assistant Attorney-General in charge of the Antitrust Division of the Department of Justice advocated compulsory licensing before a meeting of the Association of the Bar of the City of New York. I shall not discuss the pros and cons of these various proposals as they have been presented fully in most scientific publications. I am stating, however, that my experience in the exploiting of inventions and in the licensing of patents covering a wide range of conditions and subject matter, leads to the conclusion that the Arnold proposals are most unwise.

The judicial opinion by Thurman Arnold previously mentioned enunciates another strange doctrine. It was written (6) early in 1944 when he was an Associate Justice of the U. S. Court of Appeals of the District of Columbia, and was reaffirmed on rehearing later in the year. In the court action a subsidiary of the Bell System appealed the decision of the lower court in affirming the rejection by the Patent Office of certain claims of a patent application that had been assigned to the subsidiary by one of its research employees. The first opinion of the court was written jointly by Justices Arnold and Miller; on rehearing it was written by Arnold alone. The position of the court was to the effect that where a large group of men employed by a corporation are collaborating in a research or development project, invention must reach a much higher standard to warrant the granting of a patent, that is, a different criterion is required than when a single individual is involved. The opinion seemed to lean toward the "flash of genius" test for invention and intimated that such a "flash of genius" could not be present when a corporation research group was involved. These two opinions and another written by Arnold in an action involving a patent application owned by Monsanto Chemical Company (7) created much discussion at that time. The Supreme Court has not reviewed the decision and other courts apparently have not followed his double-standard thesis in determining the patentability of the results of industrial research.

Though the Antitrust Division has been blocked by Congress in its compulsory-licensing efforts it apparently is trying to achieve the same results by less direct methods with the aid of the courts. An analysis of its position in its antimonopoly suit against the Aluminum Company of America (8) indicates that it takes the position that an industrial monopoly based on and established during the life of a patent becomes an illegal one upon its expiration. Because the Aluminum Company of America chose not to grant licenses to others, it established such a monopoly in the production of aluminum under patents that expired in 1915. It was in such a favorable position when the patents expired that others could not compete with it. If this contention should be upheld in a more clear-cut case in which other monopolistic practices are not involved, then anyone operating exclusively under a patent will be subject to antimonopoly prosecution following the expiration of the patent unless effective competition develops to break the monopoly.

In recent years the Department of Justice instituted a number of suits in which corporations were charged with the wrongful use of patents in violation of the antimonopoly statutes. In those cases where the courts found the defendants guilty or where a consent decree was entered into, the Department of Justice not only asked that the defendants license their patents royalty-free but that, in addition, they agree to the drastic provision that they also issue licenses under *patents acquired in the future*. Although the defendants in one or two cases apparently were coerced into agreeing to such a consent decree, it is to the credit of the appeal courts that they have not gone along with the Department of Justice in requiring the defendants to give licenses under future patents. What inducement would there remain for the defendants to carry on further research and development work?

In view of the above record in which only a few representative cases are cited, is there any doubt of the antagonistic attitude of the Department of Justice toward industrial research? Is there any reason to believe that the objectives and activities of the Antitrust Division of the Department of Justice were not at least condoned, if not inspired, by executive and administrative superiors?

But the Antitrust Division is not alone in Washington in the desire to make changes in the patent system. As recently as September first of this year the Federal Communications Commission issued an amazing order in conjunction with its television hearing which, if enforceable, will have repercussions wherever industrial research is being conducted. The order reads as follows:

> Any person a party to this hearing who owns or has the right to sublicense inventions relating to television transmitters or receivers for either monochrome or color transmissions which are described and claimed in one or more patent applications now pending in the United States Patent Office shall file with the Commission an abstract of each such pending patent application setting forth the Patent Office filing date and serial number of the application and a brief statement of the purposes of the invention and the devices or operations claimed therein. Also each abstract shall be accompanied by a Power to Inspect the related pending patent application at the United States Patent Office by the Commission's Acting Chief Engineer (John A. Willoughby) or his nominee. These abstracts and Powers to Inspect must be filed on or before the opening date of the hearing or such later date as the Commission may by order provide.

In the above order the FCC apparently takes the position that it may pry into confidential patent applications. If this attempt is successful, it would then have the power to require the disclosure of complete information and data concerning any and all developments in the described television field regardless of whether these developments form the subject matter of patents or applications for patents. Furthermore, the FCC probably will then have set the pattern for government to pry into all industrial research.

Patents and the Courts

The courts are an important element in the composite picture which I am attempting to paint for you, and which, when viewed in its entirety, shows us how antagonistic the government is toward industrial research. The decisions of the U. S. Supreme

Court are most important because its decisions are final and are controlling over the lower courts. The courts deal largely with the patent phase though their decisions with respect to the ownership of inventions made by research employees directly affect industrial research. And, in such cases, their attitude is an exception to the rule—it is not antagonistic toward industrial research.

The decisions of the U. S. Supreme Court have grown rapidly in importance in recent years because, in the absence of any action by Congress, they have had the effect of legislative action in setting up new policies and standards of conduct. Congress, in effect, has abdicated to a considerable extent its legislative powers and the Supreme Court has moved in to exercise them. Although Congress was satisfied with the patent system in spite of its TNEC report about which it did nothing, the Supreme Court thereafter repeatedly referred to the TNEC proceedings and cited them in justification of its reformation of the patent system much as Arnold did in his previously-discussed opinion. As a result there have been upsetting and numerous changes in the patent law and in the concept of patents. It is generally agreed that a higher standard for invention also has been set, but that usually has met with approval.

The "flash of genius" decision (9) rendered in 1941 was widely discussed. It promised to be most upsetting, but fortunately it appears that most of the judiciary now ignores that dubious standard of invention.

The important decision in the so-called Lecithin case (10) is of direct interest to industrial research because it denies patent-owners the use of a practical method for collecting royalties. The Lecithin patent covered the combination of chocolate with a small amount of lecithin whereby graying of the chocolate is prevented. The company owning the patent was in the lecithin business and the selling-price of its lecithin to a manufacturer of chocolate products included the license fee for making the patented combination. The decision of the 7th Circuit Court of Appeals, which the Supreme Court refused to review, held that this practice was not permissible under the patent statutes because it extended the patent monopoly to unpatented materials, namely the lecithin. The approved procedure would be for the patent-owner to license each chocolate processor, without a tie-in sale of lecithin, who then could purchase the lecithin on the open market at competitive prices.

The Burgess companies were directly affected by the Lecithin decision and I am reciting their experience because it is typical of the effect that the decision had on many businesses. They had developed and patented (11) an acoustical-correction construction for treating walls and ceilings consisting of the combination of a sound-absorbing material and facing of perforated stiff sheet, generally sheet metal. The several large companies licensed under the patent were not interested in certain special uses, usually involving small areas, where the treatment could be installed by the ordinary artisan and the user could furnish his own sound-absorber for the patented combination from readily available sources of supply. On the other hand, Burgess produced perforated metal sheet having the correct perforation size and pattern for the desired acoustical effect, which it sold to the user at a competitive price plus the standard royalty charge of one cent per square foot. It was a most convenient way of doing business both for Burgess and the purchaser. However, the court's decision made it necessary thereafter to issue a license for each job, no matter how small, to permit the user, if he so desired, to buy his perforated metal elsewhere. The licensee usually made no effort to go elsewhere because of the small amount involved and because the perforated metal received from Burgess gave the desired acoustical effect. Furthermore, there was the further nuisance of the extra accounting necessary for the separate royalty charge, usually under a dollar. Ironically, a governmental customer, the Navy, was the chief objector to the licensing procedure necessary under the decision. The Navy was willing to purchase the perforated metal with the license fee included in the price but refused to take a license under the patent. The final outcome was that an infringement suit had to be filed against the government in the Court of Claims (12).

Several decisions of the Supreme Court have almost wiped out the right to stop contributory infringement. Thus, the patent-owner is denied a practical method for enforcing the patent monopoly by the same government that grants him the patent—the government thereby refusing to recognize the requirements of industry as they relate to patents.

It has long been the rule, established by court decisions, that a licensee cannot challenge the validity of the claim of a patent under which he is licensed. Furthermore, price-fixing of the licensee's products by the licensor (with certan limiting conditions) also has been permitted. However, the Supreme Court has now taken the position (13) that a patent-owner cannot include both conditions in the license—one or the other must be omitted. This limitation seriously affects the commercial value of patents.

It has been the age-old rule of all courts that one who sells something cannot later say it was worthless when sold for the reason that it would be dishonest. But the Supreme Court now takes the position (14) that the rule does not apply to patents. Under this new doctrine one may sell a patent, then go into competition with the new owner by making and selling the patented device, and if he sues for infringement the inventor may say he invented nothing, that the patent he sold was worthless, and that he expects to use what he sold to the new owner. Furthermore, he will not pay any royalties and will invalidate the patent.

Other decisions (15) make it illegal to fix prices under a cross-licensing arrangement though it is legal to fix prices under patents not cross-licensed. These decisions have increased the difficulties involved in using the patent monopoly to give both the patent-owner and the public the greatest possible benefits through the use of the technological advances claimed in these patents.

Time does not permit me to point out how other decisions further adversely affect the patent-owner and thereby affect industrial research. I have previously told of the research-antagonistic nature of the decisions

(6, 7) of the Court of Appeals of the District of Columbia in which the opinions were written by Thurman Arnold. It is true that in many of the discussed cases there were elements present which justified the court in taking corrective action. However, the decisions went far beyond what was required for such action and were destructive of established patent rights as interpreted almost universally by our courts for more than a century. It appears as though the goose that lays the golden eggs is slowly being strangled with Congress as a witness but doing nothing about it.

A discussion of the patents and the courts is not complete without a reference to the Court of Claims where those aggrieved may press their claims against the United States, that is, the government. After having been involved for several years in the previously mentioned acoustic-patent-infringement litigation (12) before this court, I believe I can speak for the patent-owner who appears before it. The procedure is cumbersome, long and drawn-out, and the government derives many advantages from the archaic court rules of procedure which are peculiar to this court and which advantages it would not have in the U. S. District Courts. For that reason bills have been introduced in every session of Congress in recent years to either reform the procedures in the Court of Claims or to permit the U. S. District Courts also to take jurisdiction at the option of the claimants. But Congress has failed to act so that the patent-owner continues to suffer a distinct handicap when he tries to collect for infringement of his patent by the government.

The only conclusions that can be reached from the record that has been established by the courts, particularly during the last decade, are that their decisions have made sweeping changes in the patent system, and that the judicial branch of the government is increasingly antagonistic toward industrial research. Consequently, instead of promoting the "progress of science and useful arts," as envisaged by the framers of the Constitution, government is discouraging it. Furthermore, the Supreme Court pendulum may swing still further to the left.

Congress and Research

I have referred a number of times to the failure of Congress to take action when it could have been of help to industrial research. You may have reached the conclusion that the attitude of Congress should be judged largely through its failure to take such action. I have shown how that failure to act has permitted the Supreme Court to make sweeping changes in the patent laws by judicial pronouncement. It may be said that Congress, by its failure to act, has approved these judicial pronouncements and, therefore, they represent its legislative intent. However, I do not agree with that conclusion in view of the defeat in committee in several sessions of Congress of bills based in large part on the TNEC recommendations. It seems more likely that Congress has been too busy to bother with bills that have little vote-getting significance and particularly where a presidential veto seems probable. My experience on the Patent Committee of the American Chemical Society leads to the belief that Congress, though apathetic toward industrial research, generally is not antagonistic to it in a positive way.

A variety of bills is introduced at each session of Congress which would have more or less effect on industrial research, many of which are directed at the patent system. However, few ever reach the floor of the House or Senate. These bills run the whole gamut from militant capitalism to pure socialism or worse, so that collectively, they are of no significance in this discussion.

The National Science Foundation bills are an exception, because one of them has been approved by the Senate and the House may act on it shortly. Similar bills and other proposed related legislation were discussed at length by the last Richards Memorial Lecturer, Dr. Stewart J. Lloyd (16), when he talked in 1946 on "Freedom in Science." Some parts of his address could well be repeated here. I need only to remind you at this time that these bills are antagonistic toward industrial research because they not only provide for political control of the Foundation but also because of cleverly worded provisions which an unscrupulous director could use to control industrial inventions and probably pry into private research. This power is dangerous because these bills permit the Foundation to carry on applied research.

The Atomic Energy Act of 1946 (Public Law 585) is illustrative of another type of legislation which discourages industrial research. This act gives broad powers to the government through the Atomic Energy Commission to carry on research work in the production of fissionable material or in the use of it for military purposes. The Act is so replete with prohibitions that it discourages industrial research from being done in a field where the international situation is such that it is essential that this country should continually outdistance its enemies. Laws of this type which discourage industrial research no doubt are welcomed by bureaucrats and those opposed to an incentive economy.

The under-staffing of the Patent Office, because of the failure of Congress to provide adequately for its needs, results in long delays and inadequate searching in the processing of patent applications. This affects industrial research adversely. All possible improvements in the operation of the Patent Office, however, are not contingent upon Congressional action alone. This failure to provide adequately for the operation of the Patent Office is all the more difficult to understand in view of the practically self-sustaining nature of its operations. One particular action on the part of Congress a few years ago seems unjustified—the raising of the cost of copies of patents from 10 to 25 cents. When this charge is compared to the many free and low-cost publications of other governmental bureaus, some of which cover subjects that only a bureaucrat could think of, it seems entirely out of line, particularly because the patentee pays at least thirty dollars as a final fee to issue the patent. Apparently the Patent Office is one governmental unit that does not maintain a lobby in Congress.

During the recent war scientists were much concerned by the attitude of the armed services toward research in general, and particularly industrial research. Some of us were similarly concerned during World

War I and we concluded that the armed services had learned little during the interval between the two wars. These services, though eager and anxious for the products of research, were most unwilling for industry to keep skilled research employees out of combat units, even when the research was involved in a top-secret project. In contrast there was little difficulty encountered in securing exemption for workers having few skills employed in any munitions-producing plant. Although there allegedly has been an improvement in this situation since the close of the war, I am still fearful of what would happen should we be unfortunate enough to have another war in which the supposedly improved policy would be tested.

During and since the recent war there has been much discussion about the patent policy that is to be pursued when government places research contracts. During the war the situation became acute at times because of the government's insistence that the contractor agree to stiff invention and patent clauses. The contractor, usually a manufacturer, was in a difficult position because he often was dependent entirely on government business to stay in operation. Burgess Battery Company was faced with this problem during the war and refused to take on research and other contracts which contained these unfair provisions, some of which were so wide in scope that the Company, for all practical purposes, would have handed over its patent structure to the government. As a result, the Company for a time was doing little contract research work for the government though it carried on its own extensive research program to develop primary batteries which would operate satisfactorily when subjected to the new and extreme conditions specified by the armed forces. For a time it seemed advisable to bow to the government because the Company's research workers and other technical assistants, upon learning that the Company had rejected research contracts, began to believe that the Company was not a loyal organization. However, that situation righted itself after the government backed down and revised the patent clauses so that they more closely approached the present patent section of the Armed Services Procurement Regulations (17). The present regulations are an exception to the general antagonistic attitude of the government toward industrial research and it is hoped that this condition will not be disturbed in the future.

Taxes on Research

The often-quoted phrase "The power to tax is the power to destroy" loses no significance where industrial research is concerned. Although high taxes have a devastating effect on all industry, the devastation is increased by inequitable taxes when an individual or a corporation, particularly the smaller corporation, indulges in industrial research.

There are several phases to the tax situation. The first to be discussed is that involving capitalization of research expenditures. The tax situation arising from it affects practically all research and development projects. It usually does not affect appreciably the larger corporation carrying on a research program over a period of years, but it may make the going difficult for the small operator or the operator who is on financial thin ice. This is another instance where the government's deeds belie its words to the effect that it is sympathetic toward small business organizations. In discussing the capitalization of research expenditures I shall, therefore, describe its effect particularly on the smaller operator. Although I have stated that capitalization of research does not affect the large corporation to the same degree as the smaller corporation, it does create fictitious values in the balance sheet as I shall discuss later.

By way of illustration, let us assume that several men form a partnership to further develop a practical gadget which was invented following the investigation of an obscure scientific phenomenon. A considerable amount of further research, development, and engineering work, probably extending over several years and costing a considerable sum of money, is required before it can be marketed. A partnership is formed in preference to a corporation for financing and carrying on the research and development work. This avoids certain organization expense and other complications. It has the further advantage, and this is important, that losses sustained in carrying on research and development work are deductible for income tax purposes from the current income of the partners to thereby reduce their personal income taxes during the period of time during which they must contribute heavily for this work. This deduction from current income is not possible for the stockholders of a corporation formed specificially for carrying on research and which has no operating income from which its current losses may be deducted. On the other hand, a going corporation operating at a profit would deduct current losses from current income and thereby decrease its income taxes during this period of extraordinary research outlay.

But how much of the cost of research and development work does the government permit to be charged off as an expense? Unfortunately, Congress has not seen fit to incorporate into the statutes any definite provision regarding the treatment of research expenditures for tax purposes. Industrial research, therefore, is left to the tender mercies of the Bureau of Internal Revenue whose apparent policy is to collect a maximum of revenue for the government regardless of the equities involved. Whenever the tax law is not specific, the Bureau makes its own interpretation using pertinent court decisions as a guide and then pushes the taxpayer as much as possible on the theory that he will often pay an unwarranted tax, if not too large, to avoid litigation expense and a possible adverse decision on appeal. Consistency is not a characteristic of this Bureau and the position it takes often depends upon the revenue possibilities. The Treasury usually issues regulations covering doubtful tax situations but in the matter of research and development expenditures these regulations do not clearly specify their treatment. The few cases that have reached the courts sustain the attitude of the Bureau that such costs should be capitalized.

On what theory is based the attitude that research and development costs should be capitalized? First, it should be pointed out that it is the accepted practice at the present time to capitalize research and development costs for tax purposes if a

patent application covering the work is filed. All such costs between the date of filing the application and the date of issue of the patent are included. Ignoring the tax-collecting motive for the moment, the government's harmful attitude toward such costs probably is based on the false assumption that the granting of a patent gives commercial value to an invention; whereas, neither an invention nor a patent have any such value, though much money may have been spent, until it is demonstrated that they can produce a profit. This rule is demonstrated daily in a practical way on the stock exchanges by the low prices of stocks of companies making no profit over a period of time though their balance sheets may show high net worths. The willingness of man to gamble, whether it is on a horse race or on an invention, does not in itself produce sound values warranting capitalization.

It is dinned into us repeatedly that research creates values. I have no quarrel with that assertion, but such values do not create true capital assets in the balance sheets of our present capitalistic-system industry until their profit-making capabilities have been proved. The two values should not be confused. It is for this reason, and also because but a small proportion of the patents issued by the Patent Office have a proven commercial value which might warrant their capitalization, that the balance sheets of corporations, and particularly newly-launched corporations seeking public financing, are viewed with suspicion if patents are assigned a value much greater than a dollar. The way to encourage research is not to tax possible profits in advance of their realization, but to wait until such profits are realized. It is more likely that the taxpayer may then possess the means to pay the taxes.

An experienced public accountant, when setting up the books for a partnership or small corporation, will probably advise at the present time that research and development and patent expenditures should be capitalized to avoid a tax conflict with the Bureau of Internal Revenue which would probably arise if these expenditures are charged off as an expense. Furthermore, he will probably also advise that such capitalization should be limited to costs incurred between the date of the filing of the basic patent application and its date of issue as a patent. The accountant may even volunteer the further advice, which I have found to be sound, that the yearly return of income of the corporation or partnership during the research and development period should be prepared by an accountant whose work in this special field is respected by the Bureau.

The situation arising from the policy of the Treasury Department requiring capitalization of research expenditures usually is aggravated by the delays encountered by patent applications in the Patent Office. Assuming that the research and development expense continues during this period, it is obvious that the amount of expense that has to be capitalized has a direct relation to the length of time that the application is in the Patent Office, which, at present, averages about three years. The outlook, therefore, is that a large part of the money spent for research and development, including that for patents, cannot be charged off as an expense. It is true that the costs so capitalized are depreciated over the life of the patent after it issues but that does not help financially during the critical period of continued research and development expenditures.

What happens taxwise if the research and development project fails? —a likely ending. If the patent has not issued, the application may be abandoned and the amount capitalized written off as a loss in a lump sum, with the prospect that the Treasury will maintain that it is a long-term capital loss, and therefore only 50 per cent deductible. If the patent has issued, it may be depreciated yearly over its life—an unsatisfactory drawn-out procedure. Writing off the entire project in a lump sum may be tried but it probably will be difficult and possibly costly to convince the Treasury that the patent no longer has value. In the alternative, the patent may be sold for a nominal amount to an understanding friend or dedicated to the public. The sale must be a bona fide one and it may be difficult to convince the Treasury under the circumstances. In either case the 50 per cent deductible-loss difficulty looms. Furthermore, control of the patent is lost. This is not desirable for the reason given by Burgess (18) in his Acheson Medal address in 1942 to the effect that, after a number of years, because of changing economic, social, or other conditions, an invention possibly may be salvaged and become of economic importance. Industrial research is a long-shot game and it must be played accordingly.

Another complication which aggravates the tax problem is caused by the long delays, often amounting to several years, which may be experienced in the auditing of tax returns by the Bureau. Such delays increase the amount of research and development expenditures whose deductibility status is uncertain. The accumulation could become so large that an unexpected ruling by the Bureau might precipitate a financial crisis for the organization carrying on the research. I shall discuss a specific instance later in this paper.

It is obvious that in the large corporation where there is a continuous research and development program involving many items, the depreciation deduction for the capitalized earlier-issued patents may offset in large part, or entirely, the capitalization of the current projects. For that reason the Treasury Department usually permits either method of accounting for the research and development costs of the older and larger corporations, providing the method used is consistently followed.

The research tax problem, therefore, is one which is of real importance to the individual and the smaller corporation. It was discussed in the 1945 Vannevar Bush report (1) which contained definite recommendations for legislative action. It recommended that the Internal Revenue Code be amended to give the taxpayer in every taxable year the option:

(*a*) To deduct currently all expenditures on scientific research and development of new products and processes, other than expenditures for the acquisition of tangible capital assets; or

(*b*) To capitalize such expenditures as deferred charges and amortize them according to a specified plan that in the judgment

of the taxpayer is deemed reasonable; or

(c) To deduct currently such part of these expenditures as in the judgment of the taxpayer is deemed to be a current cost and to capitalize the remainder as deferred charges and amortize them according to a specified plan that in the judgment of the taxpayer is deemed reasonable.

Clearly desirable are changes in the law following these recommendations, in which the taxpayer has the option of capitalizing or writing off research and development expenditures. It would remove the present uncertainty and give greater flexibility in the deduction of research and development costs. Congress, however, has not seen fit to encourage industrial research by rectifying this situation.

Bush further recommened that the taxpayer be given the option to amortize capitalized tangible assets used for scientific research and the development of new products, over either a period of five years or at the same rate as ordinarily allowed on such assets. That also would encourage industrial research but Congress also has not acted on that recommendation.

Finally, the capitalization of research expenditures not only creates fictitious profits and values in operating statements and balance sheets respectively, but it also creates fictitious values in estates of persons who were interested in research ventures at the time of their death, either directly as in a partnership, or less directly as in the case where the deceased has an interest in a corporation carrying on research. Such fictitious values increase estate taxes. Where such values appear on the account books or on tax returns of the deceased person, it increases greatly the difficulty of persuading the Internal Revenue Bureau to accept the true values for appraisal purposes.

Personal Holding Company Taxes

A striking example of the unexpected adverse effect that a tax law may have on industrial research is the experience of the C. F. Burgess Laboratories. Although it is an exceptional case, nevertheless, that experience should warn others who may be thinking of operating a research and development corporation along similar lines, unless the attitude of the government toward research is reversed.

Dr. Burgess, in conjunction with three research associates, launched his Laboratories in 1910 in the belief that research could provide its own endowment. In the course of proving the point, his Laboratories engaged in a broad field of activities, literally from "soup to nuts," as disclosed at the presentation to him of the Perkin Medal in 1932 (19) and the Acheson Medal in 1942 (18). The successful projects, constituting, as stated by him, one out of each fifty of those that were worked on by the Laboratories, were the basis of later profitable manufacturing operations. In all instances these operations were eventually carried on by other individuals or corporations, though the Laboratories usually established a profitable manufacturing business before assigning or licensing it to others.

The noncapitalization accounting method was followed by C. F. Burgess Laboratories. It was permitted only after considerable discussion with the Treasury Department a few years after the Income Tax Law was enacted in 1913. It should be noted that at that time income-tax rates were relatively low, industrial research was comparatively new, and the Laboratories' operations were very small in dollar volume. It even may have been possible that the Treasury Department's outlook was more objective at that time.

Where the manufacturing operations involved a capital outlay too large for the resources of the Laboratories, or where it fitted better into the operations of an established industry, the development was licensed or sold. However, Dr. Burgess followed the policy, whenever possible, of making his employees partners in results. This usually was accomplished by setting up a separate corporation for a project after the Laboratories had put the project on a profitable manufacturing basis as a separate unit, and then making it possible for the research men and others associated with the particular research project to acquire a financial interest in the new corporation as well as to operate it. As a result of this program, under which the Laboratories operated primarily as a research and development organization, it gradually built up various sources of income to finance further developments. This income came largely from its investments in securities, from royalties which were substantial in the later years, from proceeds of the sales of inventions and developments, and from manufacturing operations. In the earlier years the income from manufacturing operations was comparatively the largest source of income, but in the later years this source of income became relatively smaller as the others increased and as the manufacturing operations were disposed of. I have emphasized the type of income received by the Laboratories because of its importance in the tax situation.

The above program had been sufficiently successful over the years so that even the depression years after fateful 1929 did not do more than slow down to some extent the research and development program of the Laboratories. Then came the enactment of the Personal Holding Company Act (20) designed to eliminate avoidance of personal income taxes through the formation of Personal Holding Companies by individuals. Such companies were defined as being corporations (with certain exceptions) in which more than 50 per cent of the stock is owned by not more than five families or partners and when at least 80 per cent of the gross income is derived from dividends, interest, royalties, (other than mineral, oil, or gas royalties) and a few other types of income not of interest here. Scientists should note, therefore, that for tax purposes royalties derived from research are tainted whereas those from minerals, oil, and gas are Simon pure. Under this law all net income in any one year of a corporation meeting the above definition, not distributed to the stockholders in that year, is subjected to a confiscatory tax of about 85 per cent. Furthermore, should a corporation get in the Personal Holding Company classification in any one year it cannot again escape that classification until after

it has had Personal Holding Company income of less than 70 per cent for three consecutive years.

The C. F. Burgess Laboratories now found itself in a more difficult position. There were so few stockholders that the stock-ownership definition of a Personal Holding Company was met. Its income, as previously described, was largely of the type classified as Personal Holding Company income, the gross income of the limited manufacturing operations being but slightly over the critical 20 per cent required to avoid the undesired classification. However, that manufacturing income varied from time to time and a slump in business could occur at any time. The Laboratories' business had been built by plowing back into it a considerable proportion of the profits. The new law threatened to stop all growth because all profits in any year would have to be distributed in that year to avoid the heavy taxes on undistributed profits unless manufacturing operations were stepped up.

Then shortly afterward the second blow fell. A new Internal Revenue examiner took the position that the Laboratories should capitalize its research and development expense. If this examiner's position was upheld at Washington it would have been a serious financial blow to the Laboratories. It would definitely be in the Personal Holding Company class. If it did not wish to pay the confiscatory tax it would have to distribute yearly in dividends an amount at least equal to the net profits without any deduction for research expenditures. Its capital would be depleted each year by the amount spent for research and development. In view of the increasing hostility at Washington toward industry and the demonstrated vulnerable tax position of the Laboratories, it was decided to discontinue all research and development work for the time being, thus conserving its capital until the tax laws were revised or until government was less antagonistic toward industrial research. This decision caused the Treasury Department Conferee to reverse the examiner. As planned, the active research and development and manufacturing projects were disposed of in 1938 at book value, as was the practice in the past, to associated companies and to newly-formed organizations. The Burgess Laboratories was suddenly transformed from a creative enterprise based on an incentive economy into an investment company where financial hazards were reduced to a minimum in meeting the requirements of the Personal Holding Company law.

Summary

What I have told you today may be summarized by stating that the record shows that the government as a whole is antagonistic toward industrial research. That antagonism is particularly strong in the executive and judicial branches and is present in the legislative branch largely through the sins of omission rather than those of commission. One excellent way for the scientist and the industrialist to try to change this antagonistic attitude is for them to participate more actively in government. They should speak up and make their views known. Now, that they are in the political arena, though unwillingly, they should make the most of it. Though it is well for them to keep their Washington representatives informed about their views, I have found by experience that they must be willing to fight and take action at the election district level, including participation in local government affairs so as to better understand what makes the political clock tick.

In conclusion, let me say to you that if I have been somewhat vigorous in my expression about those who are responsible for governmental antagonism toward industrial research, the profit motive, and capitalism, it is because I am grateful for the opportunities in industrial research under the capitalistic system which I had under the inspiring leadership of Dr. C. F. Burgess—an outspoken champion of a free economy. I have learned to treasure the splendid opportunities that that system has given to all of us.

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Current Affairs

Cleveland Convention Plans

Reports coming in from Mr. Leon R. Westbrook, General Chairman of the Convention Committee for The Electrochemical Society Convention to be held in Cleveland this spring, indicate excellent progress in the plans to date.

The Statler Hotel will be the headquarters for the Convention, and the meeting dates are April 19, 20, 21, and 22, 1950. Present indications are that the Technical Program will be the largest in the Society's history. In view of this, the Committee is considering starting the technical sessions on Wednesday, April 19th, so that those attending will have the opportunity of hearing all the papers being offered for presentation.

There will be symposia on Theoretical Electrochemistry, Luminescence, Rare Metals, Industrial Electrolytics, Electric Insulation, Electrothermics, and Instrumentation.

This will be the fifth annual Luminescence Symposium held during the spring meetings of the Society. A one-day program is planned, scheduled for April 20th. Division Heads in charge of the other symposia have been very active and report satisfactory progress. As in previous years, an informal round table discussion will follow the presentation of the papers.

With reference to the social aspects of the Convention, various luncheon and dinner arrangements, which will be announced later, are being made. According to custom, the annual banquet will be held on Thursday night and Past President William G. Harvey has consented to act as toastmaster, which assures success for this event.

Arrangements have been completed for plant trips to the Lewis Flight Propulsion Laboratory operated by the National Advisory Committee for Aeronautics at the Cleveland Airport on Thursday afternoon, and to the new Goodrich Laboratories at Brecksville on Friday afternoon. A further description of these plants will appear in the February JOURNAL.

The various committees in charge of the Convention follow:

Convention Committee

George W. Heise, Honorary Chairman; Leon R. Westbrook, General Chairman; Clarence C. Rose, Vice-Chairman

Hotel Committee

N. M. Winslow, Chairman; N. C. Cahoon, J. W. Gartland, J. Prescott

Registration Committee

Leo Pucher, Chairman; F. C. Keller, J. M. Margolis, L. C. Werking

CLEVELAND ART MUSEUM OVERLOOKING FINE ARTS GARDEN

TERMINAL TOWER—WELL-KNOWN LANDMARK IN CLEVELAND

Program Committee

R. H. Schoenfeldt, Chairman; J. O. Aicher, W. O. Graff, R. S. Mackie

Entertainment Committee

C. E. Heil, Chairman; P. S. Brooks, R. O. Hull, W. Irwin, J. Prescott

Finance Committee

C. B. Sanborn, Chairman; H. P. Coates, H. C. Lee, H. B. Osborn, Jr.

Plant Trips Committee

R. C. Hienton, Chairman; D. A. Aitken, A. E. Pavlish

Publicity Committee

K. S. Willson, Chairman; M. M. Beckwith, A. H. DuRose, L. N. Elicker, P. R. Pine, H. Friedberg

Ladies Committee

Mrs. C. C. Rose, Chairman; Mrs. C. E. Heil, Mrs. R. C. Hienton, Mrs. C. B. Sanborn, Mrs. R. A. Schaefer, Mrs. L. R. Westbrook, Mrs. K. S. Willson.

All the members of The Electrochemical Society, their wives and guests, who are planning to visit Cleveland for the Convention in April, will be interested in what the city itself has to offer that will contribute to the pleasure and convenience of the visit.

Cleveland is a large, busy and prosperous city—the nation's sixth, Ohio's first. Its population numbers more than a million people, and it is the center of great trading and industrial enterprises. Its central location makes Cleveland easily accessible to visitors; nearly half of the population of the United States is within a 500-mile radius and overnight rail time of the city. Fast, modern transportation facilities of all kinds are available.

Cleveland's compact layout is another convenience. All major hotels, the shopping district, transportation points, Lake Erie, and the Public Auditorium are within a few minutes walking distance of each other. At the hub of the city's business district is the Public Square, and towering above the square is Cleveland's familiar landmark, the 52-story Terminal Tower. This building has an observation room that affords a fine view of the city. It is the tallest building in any city of the world except in New York.

Another noteworthy attraction on the Cleveland scene is the Hall. This overlooks Lake Erie and is made up of seven large buildings grouped around a 17-acre downtown garden spot. It includes the Public Library and Municipal Stadium.

An excellent shopping center caters to the tastes of discriminating women, and many beautiful parks and drives wind through the city and suburbs. The cultural and entertainment facilities are among the finest in the country. The Museum of Art, the Cleveland Symphony, Western Reserve University, and the Case School are but a few examples.

ACTIVITIES OF THE RARE METALS GROUP FOR 1949

For several years this group has been sponsoring annual symposia at the spring meeting of The Electrochemical Society. The third of these symposia was presented at Philadelphia in May 1949 and was received with considerable enthusiasm.

Papers on titanium, rhenium, zirconium, columbium, tantalum, germanium, gallium, silicon, cerium, and other rare earths, lithium, and the platinum group were presented. In addition, an informal round-table discussion was held on titanium and zirconium. Several hundred members and visitors participated in this symposium and many requests have been received for continuation of these annual affairs.

The fourth annual symposium is now being planned and will be held at the Cleveland meeting, April 19–22, 1950. The program is incomplete at this writing, but all indications are that a wide variety of the less familiar elements will be discussed.

Several subjects have been suggested for round-table discussions. It was hoped that such discussions might be held in connection with the 1950 symposium, but the overcrowded schedule will probably not permit of this.

JOHN R. MUSGRAVE

Candidates for Office—1950–51

Charles L. Faust

Presidential Candidate

Charles L. Faust, elected a Vice-President in 1947, has been very active in the Society, serving as a member of the Board of Directors for six years. In addition to the three years as a Vice-President, when he attended every full Board Meeting, he was a Manager, 1943 through 1945. He has been an active member of the Ways and Means Committee since its inception by President W. C. Moore in 1946. He has participated in the long-range program to stabilize the Society and to make it the hub of endeavor toward the advancement of the Science and Profession of Electrochemistry. This program, so ably started by the Presidents and Officers of the past few years and put into "high gear" by President Ferguson, will be continued, according to comments from him. Also, as close cooperation as possible between the Division and Section Officers and the National Officers will be maintained.

CHARLES L. FAUST

Dr. Faust joined the Society in 1937. He was Vice-Chairman of the Electrodeposition Division in 1942; Chairman in 1943; and on the Executive Committee in 1945–46; Member of the Publication Committee, 1943–44 and 1946–49; Chairman of the Nominating Committee for National Officers in 1945; General Chairman of the Columbus Convention Committee, April, 1948; and, at various times, member of Acheson Medal Committee, Perkin Medal Committee, Richards Memorial Lecturer Committee, and Young Authors' Prize Committee.

He was born in St. Louis, Missouri, November 8, 1906; attended St. Louis University and Washington University, receiving B.S. and M.S. degrees in Chemical Engineering from the latter; he was a graduate assistant at the University of Minnesota, receiving his Ph.D. in Chemical Engineering in 1934. For a brief period, he was with the Southwestern Bell Telephone Company and Western Electric Company. He joined the staff of Battelle Memorial Institute as a Research Engineer in 1934, and, at present, is Supervisor of the Electrochemical Engineering Division.

Dr. Faust's principal activities relate to metal finishing and electrolytic processes. He has pioneered in commercial electropolishing. Hobbies at the present time are Boy Scouts and Cub Scouts while "growing up again" with his two sons.

He is also a member of the American Chemical Society, the American Electroplaters' Society, and the Electrodepositors' Technical Society.

Robert J. McKay

Vice-Presidential Candidate

Robert J. McKay was born in Washington County, New York, in 1887. After receiving his B.A. degree at Butler College in 1910, he went to the University of California where he received the B.S. degree in Physical Chemistry in 1913 under Professors Lewis, Randall, and Tolman. During this period, he was an instructor at the University of California. After early work on SO_2 determinations and smoke control with western smelters, he joined the International Nickel Company in 1916. After experimental work which led to the use of pH control in nickel refining, he did work at Mellon Institute on corrosion of nickel alloys for the International Nickel Company. Subsequently, he was Superintendent of Technical Service on Monel and since 1938 has been Chemical Engineer in charge of Plating Sales and Development.

He has been Chairman of the New York Section of this Society and Chairman of its Corrosion Committee, as well as a member of several other technical societies. He has published some forty technical papers on the corrosion properties of nickel alloys, many of them in the TRANSACTIONS of this Society. He is co-author of the American Chemical Society Monograph on "Corrosion Resistance of Metals and Alloys." One of his patents covered the basic idea of a bi-metal such as copper and stainless steel for cooking utensils. He has had much to do in the past decade in bringing about the threefold increase in nickel plating.

ROBERT J. MCKAY

Oliver W. Storey

Vice-Presidential Candidate

Oliver W. Storey was born in Grafton, Wisconsin, September 15, 1888, received the B.S. degree in Chemical Engineering from the Uni-

versity of Wisconsin in 1910 and the Chemical Engineering degree in 1913. Following graduation, he was employed for a time with the Union Switch and Signal Company, the National Metal Molding Company, and from 1912 until 1914 was an instructor in Chemical Engineering at Wisconsin. Following this, he was with the Bureau of Mines at Pittsburgh on corrosion investigations for over a year. Mr. Storey joined the C. F. Burgess Laboratories in 1915 and for a period of thirty years served in different capacities such as chemical engineer and Director of Patent Department, and was an officer and director at various times in the

OLIVER W. STOREY

several Burgess Companies. He is at present a consultant for the Burgess Battery Company.

Mr. Storey joined The Electrochemical Society in 1911. He was Vice-President for two terms, 1929-31 and 1937-39. He was Chairman of the Publication Committee from 1944 until 1948 and presented the Joseph W. Richards Memorial Lecture before the recent Chicago meeting of the Society. He is also a member of the American Chemical Society, the American Society for Testing Materials, the Wisconsin Academy, the Society of Chemical Industry, the Chicago Patent Law Association, and the Technical Club of Madison, Wisconsin, of which he was President in 1930.

Economic Advantages Cited at A S A Meeting

The general theme expressed in the addresses delivered at the Thirty-first Annual Meeting of the American Standards Association, held at the Waldorf-Astoria Hotel, New York, October 11th through 14th, emphasized the economic advantages to companies making effective use of standardization. Improved efficiency, lower operation costs, and competitive advantages were shown to be gained in the national economy and also in world markets.

Following the three days of sessions, at which the various groups dealt with the problems of developing mutually satisfactory national standards, was the address by Dr. Wilson Martindale Compton, guest speaker. Dr. Compton, President of the Washington State College, is Alternate Delegate of the United States to the United Nations. His talk was on the program of economic assistance to underdeveloped countries proposed in President Truman's Point 4, and its significance to industry in the United States.

After citing various projects in this widespread program, Dr. Compton commented on the role of standards in connection with it, pointing out the value in greater capacity, and savings in foreign investments.

Among papers that are available on request from the American Standards Association, 70 East 45th Street, New York 17, N. Y., are:

"American Industry's Stake in Plant Construction Standardization"—W. H. Kiler, E. I. du Pont de Nemours & Co., Inc.

"How to Use the Standard for Thin Sheet Metals"—I. V. Williams, Bell Telephone Laboratories

"The Work of the International Electrotechnical Commission"—H. S. Osborne, American Telephone and Telegraph Company

"What Does International Standardization Mean to the United States?"—Joseph A. Greenwald, International Resources Division, U. S. Department of State

"Economic Help to Underdeveloped Countries—An Opportunity for American Industry"—Wilson M. Compton, State College of Washington.

Annual Meeting of A. I. Ch. E. in Pittsburgh

The annual National Meeting of the American Institute of Chemical Engineers was held in Pittsburgh, December 4th to 7th, inclusive.

Featured highlights of the meeting were three technical symposia and two panel discussions which were conducted concurrently with the technical papers sessions. The subjects discussed were of timely significance and special interest to chemical engineers and technical men in general. Listed below are the subjects of the symposia and members in charge:

"Industrial Waste Disposal"—R. D. Hoak, Mellon Institute, Pittsburgh, presiding.

"Atomic Energy"—J. R. Huffman, Argonne National Laboratory, Chicago, presiding.

"Vapor-Liquid Equilibria"—W. C. Edmister, Carnegie Institute of Technology, Pittsburgh, presiding.

The first of the two panel discussions, "Professional Licensing," included problems and special topics dealing with state licensing of engineers. "Corporation Training of Young Engineers" was the second panel topic. J. M. Weiss, Consulting Engineer, New York City, and Paul D. V. Manning, International Mineral and Chemical Corporation, Chicago, were the respective moderators leading the panel sessions.

The program of technical papers scheduled for the meeting was presented at the morning and afternoon sessions of the four days. Many of these papers described recent work in the fields of heat transfer, fluid flow and mass transfer, distillation, and absorption. Thermal data were presented for gases at high pressures, heat transfer media, fluidized systems, and fixed porous beds. Other papers treated velocity distribution and turbulent mixing in isothermal free jets; fluid-solid systems were discussed in relation to their kinetics and mass transfer characteristics. Other subjects were: physical separation problems, washing of liquids from conduits and porous media, elutriation of fines from fluidized systems, and separation of gases by fractional permeation through membranes, etc.

The program of plant trips was

(*Continued on page 27C*)

Corrosion Research Forum

A meeting of more than usual interest was the recent "Forum of Corrosion Research," held at the National Academy of Sciences, Washington, D. C., on November 9 and 10, 1949, and sponsored by the Office of Naval Research, Navy Department.

Arranged under four main heads, the program covered a wide range of corrosion problems and included as speakers many of the leading authorities in this field. Julius J. Harwood of the Office of Naval Research was Program Chairman. There were morning and afternoon sessions for each of the two days; the list of papers presented in the four panels, and the speakers, follow:

November 9, 1949

Welcoming Address: Dr. T. J. Killian, Science Director, Office of Naval Research

Electrochemical Fundamentals

"The Electrical Double Layer"—D. C. Grahame, Amherst College, Amherst, Mass.

"Metal-Solution Interface Potentials"—D. MacGillavry, Jr., Clark University, Worcester, Mass.

"A Polarographic Study of Corrosion Phenomena"—P. Van Rysselberghe, University of Oregon, Eugene, Ore.

Passivity and Inhibitor Studies

"Electron-Sharing and the Nature of Passivity"—H. H. Uhlig, Massachusetts Institute of Technology, Cambridge, Mass.

"Passivity Studies on Stainless Steel and Other Metal Systems"—M. G. Fontana, Ohio State University, Columbus, Ohio

"Passivity, Exchange Adsorption and Inhibitors"—N. Hackerman, University of Texas, Austin, Texas

November 10, 1949

Corrosion Mechanisms and Kinetics

"Thermodynamics and Mechanisms of Corrosion Reactions"—J. C. Warner and D. S. McKinney, Carnegie Institute of Technology, Pittsburgh, Pa.

"Bimetallic Corrosion in Neutral

(*Continued on page 27C*)

SECTION NEWS

Washington-Baltimore Section

The first official meeting of the new Washington-Baltimore Section of the Society was held at the National Bureau of Standards on November 17, 1949. The chairman, Paul L. Howard, announced that the Society Board of Directors, at their October 12th meeting, had acted favorably on the petition to set up the local section, so this was a memorable occasion for all of those participating.

The Section was honored in having present Dr. Wallace R. Brode, Assistant Director of the Bureau of Standards, who addressed the group on behalf of the Bureau, extending its greetings and congratulations. Dr. Brode further emphasized the interest of the Bureau in technical societies and their local activities and expressed the hope that the Section would meet there often.

WALLACE R. BRODE

R. M. BURNS

Dr. Abner Brenner, Vice-Chairman, next introduced Dr. R. M. Burns, Chemical Director of Bell Telephone Laboratories, who was the guest speaker of the evening. In his lecture, entitled "Electrochemistry in the Telephone Industry," Dr. Burns gave an excellent historical summary of the Society, and also congratulated the members on the establishment of the Washington-Baltimore Section. Continuing his talk, Dr. Burns gave an overall picture of the many places throughout the telephone system where the principles of electrochemistry played a very important role. From the smallest contact point to the mammoth cable network, electrochemistry is involved from the standpoint of metallurgical, chemical, battery, or corrosion problems. These have been quite successfully solved in the Bell Telephone Laboratories. The lecture was extremely interesting and informative.

A business meeting of the Section followed the technical session. The members voted to adopt the temporary regulations as permanent, and to make the temporary slate of officers permanent for the remainder of the year. The officers are as follows:

Chairman: Paul L. Howard
Vice-Chairman: Abner Brenner
Secretary: J. C. White

Dr. H. D. Holler, N. E. Promisel, and Kenneth Huston were appointed to the nominating committee.

The chairman stated that Dr. Condon, Director of the Bureau of Standards, had invited the Society to meet there during the Bureau's Semi-Centennial Celebration in 1951, and that Dr. Blum had written the Board of Directors asking them to consider it. The Section went on record as unanimously approving the invitation.

An executive meeting followed the regular meeting to organize a Con-

vention Committee to plan and set up the committees for the National Meeting. The members of this committee are Paul L. Howard, J. Putnam Marble, and Dr. Abner Brenner.

PAUL L. HOWARD, *Chairman*

Chicago Section

Dr. A. K. Graham, President of Graham, Crowley & Associates, Incorporated, addressed an audience of over 100 members and guests of the Chicago Section on the subject "Engineering for High Speed Plating" at the November 4th meeting at the Chicago Engineers' Club.

Dr. Graham gave a most informative talk on the interrelation of the many variables in increasing plating efficiency. The speaker emphasized the fact that current density alone is not a criterion of efficiency as there are many more important factors. A current density of 100 amp/ft² is high for nickel plating bumpers but 300 to 400 amp/ft² is regularly used for tin plating continuous strip, and 1200 amp/ft² is used for copper plating steel wire. Electrotypers may use from 50 to 500 amp/ft² for copper, whereas 50 amp/ft² for electroforming with copper or nickel may be too high in some cases, while 300 amp/ft² is exceeded in others.

Economic factors dictate that the highest practical rate of plating be employed in order to obtain the maximum production at the minimum cost for a given installation.

What factors determine the highest practical rate of plating? Factors most likely to be controlling are:

1. The metal being plated.
2. The bath composition.
3. The allowable temperature.
4. The available agitation or ft/min travel.
5. The required thickness of deposit, and
6. The size and shape of the article to be plated.

However, other factors may also influence the practical plating rate, such as:

7. The required physical properties of the deposit.
8. The necessity for using bath additions to obtain: (*a*) brightness; (*b*) hiding or covering power for base metal surface roughness; (*c*) dense, nontreed deposits, as in the case of acid tin deposits; or (*d*) favorable reflow characteristics in the case of electro-tin plate.

To further complicate matters the following engineering factors may, in the end, determine the plating rate that can be used:

9. Periodic reversal of the current during plating.
10. The use of diaphragms in the plating tanks.
11. The spacing between the anodes and the article being plate1.
12. The tank lining temperature limitation.
13. The purification, heating, or cooling facilities.
14. The available ampere capacity.

A. K. GRAHAM

15. The voltage of the d-c source, and last, but by no means least,
16. The coordination of chemical and quality control.

No installation—whether it be plating, electroforming, or electrotyping—is free from bottlenecks affecting the practical plating rate or production capacity. Each installation represents a compromise of many of the above factors. Management is continually confronted with the necessity of deciding what to install and when to modernize. The evaluations of the many new or improved processes and techniques present a never ending challenge to progressive executives and competent engineers. The concern that can promptly utilize worthwhile new developments sets the pace in the industry.

Mr. J. H. Conolly has been appointed Secretary of the Chicago Section to fill the term of H. D. Douglas, Jr.

J. H. CONOLLY, *Secretary*

Detroit Section

"The Use and Manufacture of Electrical Resistance Wire" was the subject discussed by W. A. Gatward, Vice-President and Chief Engineer of the Hoskins Manufacturing Company, at the meeting of the Detroit Section on November 18th. The meeting took place at Wayne University, Detroit.

Mr. Gatward described fully the chromium nickel alloys which are used for electrical resistance wire. An 80 nickel-20 chromium alloy, he said, is used for heavy duty where high temperatures are involved, and a 60 nickel-16 chromium-24 iron for milder applications. One of the major problems in the manufacture of the wire has been the proper choice of deoxidizers. The first material used was manganese followed later by aluminum and manganese. At the present time, calcium is used in combination with magnesium, aluminum, manganese, zirconium, and silicon. After using deoxidizers it is necessary to remove them, which is usually accomplished by design and by removal of the outer surface of the ingot.

Mr. Gatward described laboratory tests on the finished wire and posed the interesting question of what makes a good alloy good and a bad alloy bad. No completely satisfactory answer has been found for this question although it is felt that the solution is probably tied up with the nature and composition of the oxide scale which forms when the wire is first used. The Westinghouse Laboratories have found that the oxide is always Cr_2O_3 on good 80-20 nickel-chromium alloy and NiO Cr_2O_3 on good 60-16 nickel chromium wire.

A lively discussion period followed Mr. Gatward's very interesting talk.

M. L. BATY, *Secretary-Treasurer*

Niagara Falls Section

At the November 9th meeting of the Niagara Falls Section of The Electrochemical Society held at the

Red Coach Inn, Niagara Falls, New York, Mr. W. M. Peirce, assistant to the general manager of the Technical Department, New Jersey Zinc Company, gave a talk on the Metallurgy of Zinc.

Mr. Peirce described the ore and its sources, its roasting and sintering, and its reduction to the metal. It is Mr. Peirce's opinion that reports which have been given, indicating that proven reserves of zinc and other metals in the United States will be adequate for only a few years, give an erroneous impression. He pointed out that present ore sources have been found largely because they outcropped to the earth's surface at some point and that increased use of geophysical methods of ore prospecting should reveal many important deposits which are unknown at present because they do not happen to outcrop.

The reduction of zinc by pyrometallurgy depends upon the reducing action of carbon monoxide on zinc oxide with the zinc appearing in the vapor phase. An equilibrium condition exists in which the conversion of zinc oxide and carbon monoxide to zinc and carbon dioxide is favored by high temperature in the order of 1000–1300°C. As the temperature is lowered, carbon dioxide tends to oxidize the zinc back to the oxide. Hence there are two rather unusual problems in the pyrometallurgy of zinc: One is to get heat into the reaction mixture (combustion of fuel in the furnace charge is not a possible method because of reversal of the reaction by carbon dioxide). The second is to condense the zinc rapidly after reduction in order to avoid reoxidation. The older method, which is still in use to some extent today, is the use of small diameter ceramic vessels placed horizontally in banks in a large furnace. These horizontal retorts are manually charged and produce only about 40 to 60 pounds of zinc per day per retort.

Two radically improved processes have been commercialized in the past 20 years. One of these is an electrothermic process in which heat is generated in the charge of zinc oxide and coke by passing current through the charge. This is practiced in large units producing about 25 tons of zinc per day.

The method practiced by New Jersey Zinc Company and illustrated by the speaker with slides is the use of vertical retorts having two walls of silicon carbide brick which conduct heat from the combustion of gas to the oxidized zinc ore, carbon charge. The condenser also employs the favorable heat conduction properties of silicon carbide in the form of baffle plates which conduct the heat from the vapor exit of the retort condensing the zinc which drips into the trough at the bottom of the condenser. Such retorts and condensers have a capacity of approximately 6 tons of zinc per day.

The speaker also described newer types of condensers now being developed in which droplets of molten zinc, sprayed through the vapor by action of an agitator dipping into molten metal, condense the zinc vapor. Water cooling tubes remove the heat from the molten metal. This type of condenser requires much less space than the present type.

Zinc produced in the vertical retorts contains a large portion of the impurities of the ore. Distillation in a double column still effectively separates impurities, both high boiling such as lead and iron, and lower boiling such as cadmium, etc. Zinc of 99.99 per cent purity can be readily produced by this method and 99.999 per cent could be produced, if necessary.

Galvanizing, die castings, and brass production, in that order, are the principle uses of zinc metal today.

M. S. KIRCHER, *Secretary-Treasurer*

Future Meetings of The Electrochemical Society

Cleveland, April 19–22, 1950

Buffalo, October 11–14, 1950

Washington, Spring, 1951

Detroit, Fall, 1951

Philadelphia, Spring, 1952

Montreal, Fall, 1952

PERSONALS

R. SCOTT MODJESKA, Scientific Control Laboratories, Chicago, Illinois, has been appointed to the Membership Committee of the Society representing the Electrodeposition Division, according to an announcement by R. S. Mackie, Chairman of the Committee.

ALVIN GLASSNER, who has been on the staff of Trinity College, Hartford, Connecticut, is now residing in Morristown, New Jersey.

WALTER K. O'LOUGHLIN, formerly with the Technical Development Division of the Commercial Solvents Corporation, Terre Haute, Indiana, is now located in Washington, D. C., as an Industrial Engineer with the U. S. Air Forces.

JOHN C. KOSMOS is now affiliated with the Chemical Corporation in Springfield, Massachusetts, as a technical service representative. Mr. Kosmos was formerly a process control chemist for the Underwood Corporation in Hartford, Connecticut.

RAYMOND G. ELLIS has been appointed Advertising Manager of the JOURNAL. He was formerly with Geare-Marston, Inc., a Philadelphia advertising agency, and has been connected with many phases of advertising.

NEW MEMBERS

At the meeting of the Executive Committee held on November 10, 1949, at the office of The Electrochemical Society, Inc., 235 West 102nd Street, New York City, the following were elected to membership:

ROBERT S. ARIES, Polytechnic Institute of Brooklyn, mailing add: 26 Court Street, Brooklyn 2, New York (Electro-Organic and Industrial Electrolytic)

THOMAS D. CALLIMAN, Naval Research Laboratory, mailing add: 76 Galveston Place, S.W., Washington 20, D. C. (Dielectrics)

JOHN G. DOBSON, The Foxboro Company, mailing add: 183 East Street, Sharon, Massachusetts (Theoretical Electrochemistry)

JOSEPH E. DRALEY, Argonne National Laboratory, P.O. Box 5207, Chicago 80, Illinois (Corrosion)

HENRY R. FRIEDBERG, Radiart Corporation, 3571 W. 62nd Street, Cleveland 2, Ohio (Electrodeposition)

JERRY H. GOODE, Carbide & Carbon Chemical Company, Inc., mailing add: Box 204, Kingston, Tennessee (Alkali and Chlorine, and Electrodeposition)

DEANE O. HUBBARD, Hooker Electrochemical Company, mailing add: P.O. Box 304, Lewiston, New York (Industrial Electrolytic)

BERNARD KOPELMAN, Sylvania Electric Products, P.O. Box 86, Bayside, New York (Electrothermic)

JANUARIUS A. MULLEN, Glenvale Products Corporation, 1165 Beaufait Street, Detroit, Michigan (Organic Electrochemistry)

ALFRED M. POMMER, Electrodeposition Section, National Bureau of Standards, Washington 25, D.C. (Theoretical Electrochemistry, Organic Electrochemistry, Batteries, Corrosion, Electrodeposition, and Electronics)

JOSEPH H. ROSENBAUM, Clark University, mailing add: 66 Princeton Blvd., Lowell, Massachusetts (Corrosion and Theoretical Electrochemistry)

HENRY J. SEIM, Dept. of Chemistry, University of Nevada, Reno, Nevada (Electrodeposition)

Reinstatement

GEORGE F. KEELERIC, United Drill & Tool Corp., 411 West Ontario, Chicago 10, Illinois (Electrodeposition)

RECENT NBS PUBLICATIONS

Copies of the following publications of the National Bureau of Standards may be obtained at listed prices from the Superintendent of Documents, U. S. Governemnt Printing Office, Washington 25, D. C.

Studies on the Purification of Collagen, James M. Cassel and Joseph R. Kanagy, 9 pp., 10 cents (RP1992).

A study of several methods of purifying collagen, in which the effects of particular treatments were followed by nitrogen determinations, by electrometric titration analyses, and by electrophoretic measurements.

Viscosity of Deuterium Oxide and Water in the Range 5° to 125°C, Robert C. Hardy and Robert L. Cottington, 6 pp., 10 cents (RP1994).

The results of measurement of the absolute viscosity from 5° to 125°C of deuterium oxide (99.5 per cent pure) and of water.

Improved Single-Unit Schiefer Abrasion Testing Machine, Herbert F. Schiefer, Lawrence E. Crean, and John F. Krasny, 17 pp., 15 cents (RP1988).

A greatly improved single-unit Schiefer abrasion testing machine and a number of new abradants for use with the machine are described.

Effect of Boron on the Structure and Some Physical Properties of Plain Cast Irons, Alexander I. Krynitsky and Harry Stern, 15 pp., 10 cents (RP1987).

A study of the effects of boron additions, ranging from 0.001 to 0.48 per cent, on the properties of various gray cast irons.

ANNOUNCEMENTS FROM PUBLISHERS

ENCYCLOPEDIA OF CHEMICAL REACTIONS, Volume III, compiled and edited by C. A. Jacobson. Published by Reinhold Publishing Corporation, New York, 1949. 772 pages, 70 pages of indexing, $12.00.

This volume presents the chemical reactions of the elements cobalt, columbium, copper, didymium, dysprosium, erbium, europium, fluorine, gadolinium, gallium, germanium, gold, hafnium, holmium, hydrogen, illinium, indium, iodine, and iridium.

The text consists simply of stating the reactants and conditions, along with the products formed with balanced chemical equations wherever possible. These reactions are all of those obtainable from 251 journals. The complete reference is given for every reaction.

The work is indexed by the following: index to reagents, both by name and by formula; index to substances obtained, by name and formula. The text is arranged alphabetically by elements and under each element alphabetically according to the formula of the principal reactant. This work in no way interprets any of the chemistry involved, but simply states in a concise manner what has been reported in the literature.

BORON TRIFLOURIDE AND ITS DERIVATIVES by Harold Simmons Booth and Donald Ray Martin. Published by John Wiley & Sons, Inc., New York, 1949. 315 pages, $5.00.

This book, the first on the subject, provides a complete and organized presentation of the material. It is designed to facilitate investigations with boron trifluoride and to supply complete information on the rapid development of applications. The authors have had much practical experience in the field and had at their disposal the patents of many companies dealing with the product as well as the records of the first producers of boron trifluoride. The book also contains an extensive bibliography and index.

INTRODUCTION TO RADIOCHEMISTRY by Gerhart Friedlander and Joseph W. Kennedy. Published by John Wiley & Sons, Inc., New York, 1949. 412 pages, $5.00.

This book introduces the nature and applications of radiochemistry. It presupposes no previous knowledge of nuclear physics; a large part of the book is devoted to the fundamentals of nuclear physics and radioactivity, terminology, etc. Later chapters treat on the quantitative treatment of radioactive decay, disintegration, radiations emitted, and their applications to chemistry.

HANDBOOK OF INDUSTRIAL ELECTRONIC CIRCUITS by John Markus and Vin Zeluff. Published by McGraw-Hill Book Co., Inc., New York. 272 pages, $6.50.

This is a ready source of information about the circuits for any industrial electronic application. It contains all kinds of circuits—from counting to welding control, both simple and advanced. Diagrams and brief discussion with every circuit. Cross-referenced index.

RECENT PATENTS

Selected for electrochemists by Fred. W. Dodson, Chairman of the Patent Committee, from the Official Gazette.

September 20, 1949

Irish, R. E., 2,482,486, Electrolytic Dental Cleansing Apparatus
Ruben, S., 2,482,514, Primary Cell with Mercury Absorbent

September 27, 1949

Howe, A. E., 2,482,777, Rectifier
Chace, P. G., 2,482,897, Corrosion-Resisting Composite Metal; 2,482,898 Corrosion-Resisting Composite Metal; 2,482,899, Corrosion-Resisting Composite Metal; 2,482,900, Corrosion-Resisting Composite Metal
Smith, G. W., 2,483,110, Rectifier Treatment
Paully, F. G., 2,483,299, Measurement of Electrochemical Potentials
Polye, W. R., and Brandau, W. E., 2,483,350, Temperature Probe of the Thermocouple Type

October 4, 1949

Bonner, W. F., 2,483,397, Cathodic Protection System
Robinson, F. M., and Stein, C. D., 2,483,673, Battery Charger
Quinnell, L. E., 2,483,983, Flat Dry Cell Battery
De Marinis, F., 2,483,996, Method of Reconditioning Backing Members Having Powdered Material Facings

October 11, 1949

Booe, J. M., 2,484,068, Electrodeposition Apparatus
Gosheff, D. P., 2,484,163, Filler Plug and Electrolyte Level Indicator for Storage Batteries
Blackburn, W. E., 2,484,204, Selenium Rectifier
Nagel, F. J., and Horstman, C. C., 2,484,242, Coating Ferrous Metal Sheets with an Insulating Film
Smith, G. O., 2,484,252, Asymmetrical Conductor
Prakke, F., Keeman, W., and Rodenhuis, K., 2,484,311, Discharge Tube with Plated Electrode
Muskat, M., and Coggeshall, N. D., 2,484,422, Method of Detecting Mud Films on Exposed Rock Strata
Roedel, M. J., 2,484,529, Process for Altering the Properties of Solid Polymers of Ethylene
Whitehouse, I. P., 2,484,540, Lead Coating Process
Side, F. W., 2,484,593, Standard Cell Construction
Paterno, J. J., 2,484,726, Terminal Protector
Grant, J. A., 2,484,787, Battery Separator

October 18, 1949

Payson, P., 2,484,903, Heat and Corrosion Resisting Alloy Steel
Nebe, P. J., 2,485,061, Method of Protecting Metallic Surfaces
Scaff, J. H., and Theuerer, H. C., 2,485,069, Translating Material of Silicon Base
Freed, M. L., and Stocker, O. A., 2,485,149, Bright Nickel Plating Compositions and Process
Chambers, T. S., and Slotterbeck, O. C., 2,485,258, Electrodepositing Lead on Copper from a Nitrate Bath
Gerbes, O., 2,485,276, Method for Inhibiting Corrosion Caused by Liquid Aluminum Halide Catalysts
Tyson, C. W., 2,485,335, Polymer Separation
Case, S. L., 2,485,358, Free Machining Steel
MacFarland, A. M., 2,485,397, Dry Cell and Battery Seal
Meiklejohn, W. H., 2,485,402, Electric Rectifier and Method of Production
Wrigley, D. A., 2,485,468, Thermocouple for Fire Detection
Allen, J. S., and Rossi, B. B., 2,485,469, Method and Means for Detecting Ionization
Cotton, W. J., 2,485,476, Method of Producing Nitrogen Oxide
Cotton, W. J., 2,485,477, Method of Producing Nitrogen Oxide in an Electrical Discharge Apparatus
Cotton, W. J., 2,485,478, Method of Electrochemically Producing Nitrogen Oxide in the Presence of Tantalum Electrodes
Cotton, W. J., 2,485,479, Electrochemical Production of Nitrogen Oxide
Cotton, W. J., 2,485,480, Electrochemical Production of Nitrogen Oxide
Cotton, W. J., 2,485,481, Electrochemical Production of Nitrogen Oxide
Thompson, R. W., 2,485,516, Shallow Plane Proportional Counter

October 25, 1949

Chester, A. E., and Reisinger, F. F., 2,485,563, Zinc Electroplating Compositions and Method for the Electrodeposition of Zinc
Chester, A. E., and Reisinger, F. F., 2,485,565, Cadmium Plating
Elliott, M. A., 2,485,579, Fluid Inspection Apparatus
Gray, F., 2,485,589, Selenium Rectifier and Photocell
Haigh, L. B., 2,485,593, Rectifier and Method of Making the Same
Tribble, W. H., 2,485,678, Facsimile Recorder
Bahner, C. T., 2,485,803, Electrolysis of Primary Nitroalkanes
Stevens, C. R., 2,485,851, Electric Melting Furnace
Miller, N. F., 2,485,903, VII Type Phosphor
Miller, W. A., 2,485,904, High-Frequency Thermocouple for Concentric Lines
Miller, W. A., 2,485,905, High-Frequency Thermocouple for Wave Guides
McMillan, G. W., 2,485,982, Electrolytic Production of Aminoalcohols
Butler, K. H., 2,486,112, Barium Strontium Lead Silicate Phosphor
Gravley, C. K., 2,486,150, Piezoelectric Transducer and Method for Producing the Same
Stumbock, M. J., 2,486,341, Electrical Contact Element Containing Tin Oxide

November 1, 1949

Otto, E. M., 2,486,432, Conductivity Cell for Viscous Materials
Perrin, T. S., and Seybert, R. A., 2,486,433, Production of Flux for Magnesium and Magnesium Base Alloys
Clark, C. W., and Schloen, J. H., 2,486,464, Method of Producing Sodium Selenate
Dahlman, V., 2,486,520, Air Filter
Dahlman, V., 2,486,521, Electrical Dust Precipitator
Osterheld, C. M., 2,486,871, Anticorrosion Unit
Ransburg, H. P., and Miller, E. P., 2,486,877, Overspray Recovery for Spray Booths
Fergus, D. J., 2,486,936, Combination Outlet Fitting and Sacrificial Anode
Hammer, I. P., and Rust, J. B., 2,486,943, Polymerization Process in Aqueous Thiocyanate Solutions

FUTURE MEETINGS OF OTHER ORGANIZATIONS

PLANT MAINTENANCE SHOW AND CONFERENCE, Cleveland, Ohio, January, 16–19

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, annual meeting, Dallas, Texas, January 23–27

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, winter general meeting, New York City, January 30–February 3

ESSEX ELECTRICAL LEAGUE, 6th annual electrical industrial exposition, Newark, New Jersey, March 7–10

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION, Edgewater Beach Hotel, Chicago, Illinois, March 13–16

GREATER NEW YORK SAFETY COUNCIL, 20th annual safety convention and exposition, Hotels Statler and Governor Clinton, New York City, March 28–31

A. G. A. DISTRIBUTION, MOTOR VEHICLE, AND CORROSION CONFERENCE, Book Cadillac Hotel, Detroit, Michigan, April 3–5

EMPLOYMENT SITUATIONS

Please address replies to box shown, c/o The Electrochemical Society, Inc., 235 W. 102nd St., New York 25, N. Y.

Positions Available

ELECTROCHEMIST OR METALLURGIST: Recent college graduate, B.S. degree and under 30 years of age, with an interest in the field of corrosion and protective paints and coatings, wanted for position in Development and Research Department of large East Coast Shipyard. *Reply to Box A-215.*

PHYSICAL CHEMIST, Ph.D. for work in a new corrosion laboratory of a large petroleum refiner in the Middle West. Exceptional opportunity for a man with good training and some experience in the field of corrosion. *Reply to Box A-216.*

Positions Wanted

CHEMICAL ENGINEER, 34, for research or development, industrial or academic. Doctorate 1947, with background in physical, inorganic, organic chemistry, physics, and mathematics. Experienced in electrochemistry, metallurgy, corrosion, and administration. *Reply to Box 334.*

INORGANIC CHEMIST, Ph.D., 25 years' research, development with major companies; experienced in modern laboratory techniques, pilot plant design and operation; writing reports, surveys, patent studies, economic evaluations; knowledge of many fields of chemistry and science, literature, languages; high offices in professional organization. Desires responsible position in development research. *Reply to Box 335.*

Annual Meeting of A.I.Ch.E. in Pittsburgh

(*Continued from page 21C*)

particularly extensive, dramatizing the magnitude of Pittsburgh's industries. Twelve trips were scheduled in this area which is sometimes referred to as the "workshop of the world." The companies included in the group of plants to visit were:

Aluminum Company of America, New Kensington, Pa.; U. S. Bureau of Mines, Bruceton Experimental Station, Bruceton, Pa.; Carnegie-Illinois Steel Corporation, Clairton, Pa.; Climax Molybdenum Company, Langeloth, Pa.; Elliott Company, Jeannette, Pa.; Gulf Research & Development Company, Pittsburgh, Pa.; Jones and Laughlin Steel Corporation, Aliquippa Works, Aliquippa, Pa.; Koppers Company, Inc., Kobuta Plant, Kobuta, Pa.; Mellon Institute, Pittsburgh, Pa.; Pittsburgh Consolidation Coal Company, Disco Plant, Imperial, Pa.; St. Joseph Lead Company, Josephtown, Pa.; and Westinghouse Electric Corporation, East Pittsburgh, Pa.

Another feature of the Institute's program was the presentation of several professional awards in chemical engineering.

The Program Committee was under the able chairmanship of Dr. James Coull, Head, Chemical Engineering, University of Pittsburgh. Dr. William H. McAdams, Professor of Chemical Engineering, Massachusetts Institute of Technology, delivered the first Institute lecture on the subject of "Heat Transmission."

Among the interesting personalities connected with the meeting were the following three past-presidents of the Institute who are Pittsburghers of long standing: Francis C. Frary, Director of Research, Aluminum Company of America; Webster N. Jones, Dean of Engineering, Carnegie Institute of Technology; and E. R. Weidlein, Director, Mellon Institute.

Corrosion Research Forum

(*Continued from page 22C*)

Electrolytes"—C. W. Borgmann, University of Nebraska, Lincoln, Nebr.

"Corrosion of Metals in Contact with Liquids"—G. R. Hill, University of Utah, Salt Lake City, Utah

"Corrosion Studies on Aluminum and Magnesium and their Alloys"—W. Beck, Lehigh University, Bethlehem, Pa.

High Temperature Corrosion Studies

"Diffusion Mechanisms During Oxidation"—M. T. Simnad, Carnegie Institute of Technology, Pittsburgh Pa.

"Surface Film Formation at Elevated Temperatures"—M. G. Fontana, Ohio State University, Columbus, Ohio

"Oxidation Studies in Fe-Cr Alloys"—H. J. Yearian, Purdue University, Lafayette, Indiana

"Kinetics of Corrosion Reactions at High Temperatures"—D. D. Cubiccioti, Jr., Illinois Institute of Technology, Chicago, Ill.

"Corrosion and Erosion Reactions at Elevated Temperatures"—W. J. Moore, Catholic University, Washington, D. C.

"High Temperature Oxidation Studies"—H. H. Uhlig, Massachusetts Institute of Technology, Cambridge, Mass.

A more detailed account of the topics discussed at the forum will appear in a future issue of the JOURNAL.

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